

The opinion in support of the decision being entered today was not written for publication and is not binding precedent of the Board.

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AUG 12 2005

U.S. PATENT AND TRADEMARK OFFICE
BOARD OF PATENT APPEALS
AND INTERFERENCES

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte JIAN J. CHEN, ROBERT G. VELTROP
and THOMAS E. WICKER

Appeal No. 2005-1046
Application 09/821,027

ON BRIEF

Before OWENS, BLANKENSHIP and SAADAT, *Administrative Patent Judges*.

OWENS, *Administrative Patent Judge*.

DECISION ON APPEAL

This appeal is from a rejection of claims 11-25 and 28-40. Claims 1-10 have been withdrawn from consideration and claims 26 and 27 have been canceled.

THE INVENTION

The appellants claim a plasma processor having a specified plasma excitation coil. Claims 11 and 28 are illustrative:

11. An inductive plasma processor for processing a workpiece, comprising a plasma excitation coil, the coil including plural parallel connected windings, a source for supplying power to the plural parallel connected windings, the source being connected to the plural parallel connected windings for causing current from the source to flow in parallel to the plural parallel connected windings, variable impedance arrangements respectively coupled with the plural parallel connected windings for varying the currents flowing from the source to each of the plural parallel connected windings, and a controller coupled to the source and components for (a) directly varying the total output power of the source and the total power the source supplies to the plural parallel connected windings and (b) varying values of components of the variable impedance arrangements so that for different distributions of electromagnetic fields the source is arranged to supply different amounts of total power and different relative currents to the plural parallel connected windings.

28. A vacuum plasma processor for processing a workpiece, comprising a plasma excitation coil, the coil including at least one winding, a source for supplying power to the at least one winding, the source frequency and the length of the at least one winding being such that there are no substantial standing wave current variations along the length of the at least one winding.

THE REFERENCES

Tomioka et al. (Tomioka)	5,897,713	Apr. 27, 1999
Sato et al. (Sato)	5,907,221	May 25, 1999
Chu et al. (Chu)	6,051,073	Apr. 18, 2000
van Gogh et al. (van Gogh)	6,579,426	Jun. 17, 2003 (filed May 16, 1997)
Chen et al. (Chen) (PCT application)	WO 00/00993	Jan. 6, 2000

THE REJECTIONS

Claims 11 and 31 stand rejected under 35 U.S.C. § 102(a) as being anticipated by Chu. The claims stand rejected as being obvious under 35 U.S.C. § 103 as follows: claims 12, 32-35, 37 and 39 over Chu; claims 11, 12, 31-35, 37 and 39 over Sato in view of Tomioka or Chu; claims 13-16, 19-25, 28-30, 36, 38 and 40 over 1) Chu in view of Chen,¹ and 2) Sato in view of Tomioka or Chu, further in view of Chen; and claims 17 and 18 over 1) Chu in view of van Gogh, and 2) Sato in view of Tomioka or Chu, further in view of van Gogh.²

OPINION

The rejection of claims 11 and 31 under 35 U.S.C. § 102(a) over Chu is affirmed. The rejection of claims 12, 32-35, 37 and 39 under 35 U.S.C. § 103 over Chu is reversed. The rejection of claims 11, 12, 31-35, 37 and 39 under 35 U.S.C. § 103 over Sato in view of Tomioka or Chu is affirmed as to claim 11 and

¹ Claim 18 is withdrawn from this rejection in the examiner's answer (page 27).

² The examiner also relies upon U.S. 6,238,512 to Li et al. (answer, pages 19-22 and 26). Because this reference is not included in a statement of a rejection, it is not properly before us. See *In re Hoch*, 428 F.2d 1341, 1342 n.3, 166 USPQ 406, 407 n.3 (CCPA 1970). Consequently, we have not considered Li et al. in reaching our decision.

reversed as to claims 12, 31-35, 37 and 39. The rejections of claims 13-16, 19-25, 28-30, 36, 38 and 40 under 35 U.S.C. § 103 over 1) Chu in view of Chen, and 2) Sato in view of Tomioka or Chu, further in view of Chen, are affirmed as to claims 13-15, 36, 38 and 40 and reversed as to claims 16, 19-25 and 28-30. The rejections of claims 17 and 18 over 1) Chu in view of van Gogh, and Sato in view of Tomioka or Chu, further in view of van Gogh, are affirmed as to claim 17 and reversed as to claim 18.

The appellants state that except for claims 35, 37 and 39, the claims stand or fall separately (brief, page 7). We address the appellants' claims separately to the extent justified by the appellants' arguments.

*Rejection of claims 11 and 31
under 35 U.S.C. § 102(a) over Chu*

Chu discloses a plasma treatment system for implanting impurities (col. 5, lines 20-22). The system includes a vacuum chamber (14) having dielectric windows (26), some of which have removably attached to them radio frequency (RF) plasma sources (40) which are connected to an RF generator (66) and have, in one embodiment, helical or pancake antennas (46) located within an outer shield/ground (44) (col. 5, lines 27-36 and 48-50). Each antenna has a tuning capacitor connected in parallel

therewith which is controlled by a signal from a controller (62) (col. 5, lines 51-53). In one embodiment the RF generator is controlled by a signal from the controller (col. 5, lines 58-59). By individually adjusting the tuning capacitors, the output power from each RF antenna can be adjusted to maintain uniformity of the generated plasma (col. 5, lines 53-56).

The appellants argue that Chu maintains plasma uniformity by using uniform electromagnetic fields to excite the plasma, which is opposite to the requirement in the appellants' claim 11 that a controller achieves different distributions of electromagnetic fields by the controller directly varying the total output power of the source and varying the values of the variable impedance elements (brief, pages 8-10). Chu's disclosure that the RF generator is controlled by a signal from a controller (col. 5, lines 57-58) indicates that the total power output of the RF generator is directly varied, and Chu's disclosure that the output power from each RF antenna is adjusted by individually adjusting the tuning capacitors (col. 5, lines 53-56) indicates that Chu varies the values of the variable impedance elements. Thus, Chu indicates that his processor is the same as, not opposite to, the appellants' processor. The appellants rely upon the same argument regarding claim 31 (brief, pages 10-11).

For the above reasons we are not convinced of reversible error in the examiner's rejection of claims 11 and 31 under 35 U.S.C. § 102(a) over Chu. We therefore affirm that rejection.

*Rejection of claims 12, 32-35, 37 and 39
under 35 U.S.C. § 103 over Chu*

The examiner argues that Chu's apparatus is capable of controlling the total power to the RF generator and controlling the variable impedance arrangements of the antennas, and that varying the relative currents to the antennas in the manner recited in the appellants' claims 12, 32-35, 37 and 39 would have been an obvious design choice to control the distribution and uniformity of the plasma (answer, pages 7 and 16-17). The examiner, however, has not provided evidence or technical reasoning which shows that Chu would have fairly suggested, to one of ordinary skill in the art, a processor that can control the distribution and uniformity of the plasma by controlling the relative currents to the antennas in the manner set forth in the appellants' claims 12, 32-35, 37 and 39. The examiner has provided mere speculation to that effect, and such speculation is not sufficient for establishing a *prima facie* case of

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obviousness. See *In re Warner*, 379 F.2d 1011, 1017, 154 USPQ 173, 178 (CCPA 1967), cert. denied, 389 U.S. 1057 (1968); *In re Sporck*, 301 F.2d 686, 690, 133 USPQ 360, 364 (CCPA 1962).

The examiner argues that the function of providing different electromagnetic field distributions to supply current to the windings in the manner required by the appellants' claims 12, 32-35, 37 and 39 does not distinguish the apparatus structurally but, rather, is mere intended use which is not given patentable weight in apparatus claims (answer, pages 16-22). The ability to provide the distributions of electromagnetic fields required by those claims is a structural characteristic of the claimed apparatus, and the examiner has not established that Chu's apparatus has that characteristic or that Chu would have fairly suggested that characteristic to one of ordinary skill in the art.

For the above reasons we reverse the rejection of claims 12, 32-35, 37 and 39 under 35 U.S.C. § 103 over Chu.

*Rejection of claims 11, 12, 31-35, 37 and 39
under 35 U.S.C. § 103 over Sato in view of Tomioka or Chu*

As discussed above regarding the rejection of claim 11 under 35 U.S.C. § 102(a) over Chu, that claim is anticipated by Chu. Because anticipation is the epitome of obviousness, see *In re Skoner*, 517 F.2d 947, 950, 186 USPQ 80, 83 (CCPA 1975); *In re Pearson*, 494 F.2d 1399, 1402, 181 USPQ 641, 644 (CCPA 1974), we affirm the rejection of claim 11 under 35 U.S.C. § 103 over Sato in view of Tomioka or Chu.

Sato discloses an inductively coupled plasma reactor having outer (150a-h) and inner (150i-k) antenna loops, each of which is connected through one of a bank of variable capacitors (160a-k) to a single commonly shared RF generator (170) (col. 4, lines 5-15). A source power distribution controller (180) controls each individual variable capacitor in the bank of variable capacitors, and a user governs the RF power levels in each of the independent antenna loops through that controller (col. 4, lines 16-21).

Tomioka discloses a plasma generating apparatus having a first RF power supply (7) applied to a first coil (3), and a second RF power supply (10) applied to a second coil (4) (col. 8,

lines 24-30). The frequencies, phases and powers of the first and second power supplies are controlled by an RF power supply controller (14) (col. 8, lines 34-37).

The examiner argues that an apparatus according to Sato in view of Tomioka or Chu would be capable of controlling the total power and the variable impedance arrangements in different windings and that, therefore, controlling the current flows to the windings in the manner required by the appellants' claims 12, 31-35, 37 and 39 would have been an obvious design choice to control the distribution and uniformity of the plasma (answer, pages 9-10. The examiner also argues that the function of providing different electromagnetic field distributions is an intended use and is not given patentable weight in apparatus claims (answer, page 24). These are the same arguments made in the above-discussed rejection under 35 U.S.C. § 103 over Chu, and are not persuasive for the reasons given regarding that rejection. Accordingly, we reverse the rejection of claims 12, 31-35, 37 and 39 under 35 U.S.C. § 103 over Sato in view of Tomioka or Chu.

*Rejections of claims 13-16, 19-25, 28-30, 36, 38 and 40
under 35 U.S.C. § 103 over Chu in view of Chen
and over Sato in view of Tomioka or Chu,
further in view of Chen*

Chen discloses (abstract):

A radio frequency plasma multiple-coil antenna allows for controllable, uniform inductive coupling within a plasma reactor. According to exemplary embodiments, multiple coils are positioned on a dielectric window of a plasma chamber, and are powered by a single radio frequency generator and tuned by a single matching network. Each coil is either planar or a combination of a planar coil and a vertically stacked helical coil. The input end of each coil is connected to an input tuning capacitor and the output end is terminated to the ground through an output tuning capacitor. The location of the maximum inductive coupling of the radio frequency to the plasma is mainly determined by the output capacitor, while the input capacitor is mainly used to adjust current magnitude into each coil.

The appellants concede that Chen discloses the individual features added by claims 13-15, 18, 36, 38 and 40 (brief, page 18). The appellants argue that the coils of Chu and Chen differ extensively, and in support of that argument point out that Chu's coils 1) are small, offset and shielded from each other, 2) produce fields that are coupled through separate windows, and 3) are each associated with a particular, relatively small area of the plasma chamber, whereas Chen's coils 1) are generally coaxial, 2) are relatively large, 3) couple their fields through a common window, and 4) are not shielded (brief,

page 18; reply brief, pages 13-14). The appellants argue that because the coils of Chu and Chen differ extensively, one of ordinary skill in the art would not have modified Chu's magnetic fields based on Chen's disclosure so that the location and/or maximum amplitude of the current in Chu's windings are varied (brief, pages 18-19). The appellants also argue that because each of Chu's coils couples a field to a small region in the chamber there is no need to vary the location and/or maximum amplitude of the current in the different windings. See *id.*

Chen's disclosure that his coil configuration permits varying and controlling the plasma density in different radial and azimuthal regions to obtain radially and azimuthally uniform plasma (abstract; page 4, lines 4-16) would have fairly suggested, to one of ordinary skill in the art, using Chen's coil configuration for each of Chu's coils so as to obtain radial and azimuthal uniform plasma in the region of each coil, thereby improving the overall plasma uniformity desired by Chu (col. 4, lines 14-17).

We therefore affirm the rejections of claims 13-15, 36, 38 and 40 under 35 U.S.C. § 103 over Chu in view of Chen and over Sato in view of Tomioka or Chu, further in view of Chen.

Regarding claims 16, 19, 24, 25 and 28-30 the examiner argues that "if the frequency of the [i.e., Chen's] source was selected to be zero or if no power was applied to the coil, no substantial standing wave current variations would occur along the length" (answer, page 28). The examiner has not explained how Chen's device is capable of functioning as a plasma processor if the frequency of the source is zero or if no power is applied to the coil. The examiner also argues that "it is well known in the art [to] alter the length of a winding to achieve a desired process" (answer, page 28), but the examiner provides no support for this argument.

As for claims 20-23 the examiner argues that "the function of providing adjacent windings having standing wave current maxima that are radially opposite to each other is considered intended use and is not given weight in apparatus claims (answer, pages 28-29). The examiner is incorrect because the capability of providing 1) maximum amplitude of a standing wave current in one winding that differs from the maximum amplitude of a standing wave current in the remainder of the coil, and 2) adjacent windings having standing wave current maxima that are radially opposite from one another, is a structural characteristic of the claimed plasma processor.

For the above reasons we reverse the rejections of claims 16, 19-25 and 28-30 under 35 U.S.C. § 103 over Chu in view of Chen and over Sato in view of Tomioka or Chu, further in view of Chen.

*Rejections of claims 17 and 18 under 35 U.S.C. § 103
over Chu in view of van Gogh and over
Sato in view of Tomioka or Chu,
further in view of van Gogh*

Van Gogh discloses (col. 2, line 56 - col. 3, line 12):

In accordance with one aspect of the present invention, it has been found that the reactance between the RF coil and the ground can be cyclicly [sic] and continuously tuned during a sputtering operation to move or vary the RF voltage distributions along the RF coil so that minima and maxima points of the RF voltage distribution along the coil are not fixed at particular regions of the coil. Instead, the RF voltage distribution can be repeatedly moved around the coil in a rotational or other motion. In addition, the ionization pattern of the plasma associated with the RF voltage distribution may be similarly moved in conjunction with the movement of the RF voltage distribution. As a consequence, the RF coil and substrate can be more uniformly and symmetrically heated, by time-averaging, because a "hot spot" of sputtering can be avoided. In addition, the coil itself may be more uniformly sputtered and the deposition material can be more uniformly deposited.

In one embodiment, the tunable variable reactance includes a plurality of capacitors of different capacitive values and a switch which cyclically couples each capacitor to the coil in sequence. In this manner, the reactance between the coil and ground is cyclicly [sic] altered during deposition to shift the voltage distributions along the coil to improve uniformity.

The appellants acknowledge that van Gogh discloses the capacitors recited in claim 17 (brief, page 24). The appellants argue that one of ordinary skill in the art would not have modified Chu's apparatus in view of van Gogh because van Gogh's coil has a diameter that is almost as large as that of the chamber and supplies all of the energy to the plasma, whereas Chu uses several small plasma sources each including a winding that supplies energy only to a small portion of the chamber (brief, pages 24-25).

Van Gogh's disclosure set forth above would have fairly suggested, to one of ordinary skill in the art, the use of van Gogh's capacitors with each of Chu's coils to move the RF voltage around each separate coil to improve the plasma uniformity around each coil, thereby improving the overall plasma uniformity desired by Chu (col. 4, lines 14-17). Accordingly, we affirm the rejections of claim 17 under 35 U.S.C. § 103 over Chu in view of van Gogh and over Sato in view of Tomioka or Chu, further in view of van Gogh.

With respect to claim 18 the examiner argues that "the function of arranging the first and second capacitors so their values control the magnitude and location of the standing wave current is considered intended use and is not given patentable

weight in apparatus claims" (answer, page 32). The examiner is incorrect because the arrangement of the capacitors such that they are capable of controlling the magnitude and location of the maximum amplitude of a standing wave RF current in their respective windings is a structural characteristic of the claimed plasma processor. Consequently, we reverse the rejections of claim 18 under 35 U.S.C. § 103 over Chu in view of van Gogh and over Sato in view of Tomioka or Chu, further in view of van Gogh.

DECISION

The rejection of claims 11 and 31 under 35 U.S.C. § 102(a) over Chu is affirmed. The rejection of claims 12, 32-35, 37 and 39 under 35 U.S.C. § 103 over Chu is reversed. The rejection of claims 11, 12, 31-35, 37 and 39 under 35 U.S.C. § 103 over Sato in view of Tomioka or Chu is affirmed as to claim 11 and reversed as to claims 12, 31-35, 37 and 39. The rejections of claims 13-16, 19-25, 28-30, 36, 38 and 40 under 35 U.S.C. § 103 over 1) Chu in view of Chen, and 2) Sato in view of Tomioka or Chu, further in view of Chen, are affirmed as to claims 13-15, 36, 38 and 40 and reversed as to claims 16, 19-25 and 28-30. The rejections of claims 17 and 18 over 1) Chu in view of van Gogh, and Sato in view of Tomioka or Chu, further in view of van Gogh, are affirmed as to claim 17 and reversed as to claim 18.

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No time period for taking any subsequent action in
connection with this appeal may be extended under 37 CFR
§ 1.136(a)(1)(iv).

AFFIRMED-IN-PART

Terry J. Owens)
TERRY J. OWENS)
Administrative Patent Judge)

Howard B. Blankenship)
HOWARD B. BLANKENSHIP)
Administrative Patent Judge)

Mahshid D. Saadat)
MAHSHID D. SAADAT)
Administrative Patent Judge)

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Allan M. Lowe
Lowe, Hauptman, Gilman & Berner, LLP
1700 Diagonal Road, Suite 310
Alexandria, VA 22314